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Dynamic recrystallization of low stacking fault energy metals

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The dynamic recrystallization mechanism occurring during hot deformation of low stacking fault energy metals ("classical" or "discontinuous" dynamic recrystallization, DDRX) has been widely investigated, in particular in austenitic carbon steels. It basically involves the repeated nucleation and subsequent growth of new grains, while strain hardening and dynamic recovery are simultaneously operating. After a transient stage where the flow stress and the microstructural changes are influenced by the initial state of the material, a steady state is generally reached at large strains, which depends only on the prescribed strain rate and temperature. It is very important to understand these phenomena for controlling the final microstructures (e.g., grain sizes, boundary misorientations, textures) through an optimization of the thermomechanical process.

Two sets of experimental data are discussed and compared, relative to: (i) An austenitic A304 type stainless steel, in which DRX occurs very quickly due to the high mobility of grain boundaries. Dynamic nucleation takes place mainly by the generation of growth twins. (ii) A nickel base 718 superalloy. In this case, the migration of grain boundaries is quite slower as a result of a more efficient dynamic recovery that decreases the driving forces, and/or the presence of niobium atoms segregated in the boundaries. Two types of nucleation are observed, either by local crystallographic rotations of specific subgrains, or by twinning. The first of these two mechanisms is similar to "continuous" dynamic recrystallization (CDRX) that is commonly observed in high stacking fault energy metals, which suggests that the behaviour of alloy 718 is intermediate between the two types of DRX.